AUDIT OF PRIORITY SPECIES OF RIVERS AND WETLANDS

White-clawed Crayfish *Austropotamobius pallipes* in South Hampshire and the Isle of Wight

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Environment Agency
Hampshire Area
Sarum Court
Sarum Road
Winchester
Hants SO22 5DP

Hampshire & the Isle
of Wight Wildlife Trust
8 Romsey Road
Eastleigh
Hants SO50 9AL

Adrian Hutchings
Sparsholt College
Winchester
Hants SO21 2NF

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Introduction

The following report has been commissioned by the Environment Agency (Southern Region).It has been prepared on behalf of the Hampshire and Isle of Wight Wildlife Trust and is one of seven audits covering species of rivers and wetlands that are considered to be a priority for conservation action by the Environment Agency and its partners.

The species covered by the audits are:

- Wetland and river molluscs:
- Fresh water Cray-fish
- Southern Damselfly
- Marsh Fritillary
- Black Bog Ant
- Birds of rivers and reedbeds
- Water Vole

Level of Confidentiality

Given the endangered status of the white-clawed crayfish in Hampshire and the sensitive nature of all the sites involved, most in private ownership, it is essential that the locational details noted within the report remain strictly confidential. Many riparian owners have requested this level of confidentiality and therefore it is vital if good working relationships are to be maintained into the future. The Bartley Water site is highly accessible to the general public and similarly should remain confidential.
Access to sites should also be controlled generally and only permitted through consultation with the Environment Agency, the manager of the Native Crayfish Project, Hampshire and the riparian owners concerned.

1.0 Description of *A. pallipes*

1.1 General

There is only one species of freshwater crayfish indigenous to the British Isles - ***Austropotamobius pallipes*** (Lereboullet). Known as the White-clawed or Atlantic Stream crayfish this species belongs to the relatively advanced Malacostracan crustaceans, and lies within the order Decapoda. This order also includes the decapod shrimps, prawns, lobsters and crabs (Gledhill et al, 1993).

1.2 Detailed description

Freshwater crayfish are like small lobsters in appearance (fig. 1). Adult individuals average about 10 cm in body length, but larger specimens do occur.

The colour of live specimens of *A. pallipes* is generally brown, dark brown, red or olive and the chelae or claws are usually white or dirty white ventrally, hence it's common name. Colour however, is not a reliable feature for identification. The prominent spines on the shoulders of the thorax behind the cervical groove (fig. 2a) and the single pair of post-orbital spines or ridges are

more reliable features (fig. 2b). In addition the nose-like rostrum has sides which are smooth and converge towards the base of a small triangular apex (fig. 2c). The body of this species is relatively smooth, yet the robust chelae are dorsally rough and knobbly.

Small immature specimens and some females may be difficult or impossible to identify because the key characters are not fully formed or differ from those of the adults. Live juveniles of *A. pallipes* can be identified by the presence of spines or small lumps (when viewed from the side) on the shoulders of the thorax, behind the cervical groove. The shape of the rostrum is also clearly defined in young natives (D.M Holdich, pers comm.).

A full treatment of the biology of this species is given in Holditch and Lowery, 1988.

2.0 Description of habitat requirements

Across mainland Europe *A pallipes* occupies a wide range of running and static water habitats where it can become the dominant macroinvertebrate. Britain represents the northern-most part of it's range in Europe and as such the ecological requirements of this species are more exacting. Where native crayfish are found in Britain their abundance is influenced by specific in-channel and riparian habitat conditions, including the physical and chemical properties of the water body, the structure of the streambed and banksides and there may also be an important link with adjacent landuses.

These factors are described in the following sections.

2.1 Water quality and temperature conditions:

The distribution of this species is determined largely by geology and water quality, being absent from areas with soft, acid and/or polluted waters (Holditch and Reeve, 1991) It is almost always confined to clean, mineral-rich alkaline waters (pH 7-9) where there is sufficient calcium (>5 mg.l-1) for the hardening of the exoskeleton after moulting. The siliceous regions of the British Isles are devoid of crayfish, and they only appear where some calcareous deposit or outcrop enhances the calcium content of the water in these areas.

This species may be considered as a useful biological indicator of water quality (Jay and Holditch, 1981), the majority of records for this species are from NWC Class 1A and 1B waters (Holditch and Reeve, 1991). Changes in chemical water quality may, if acute, eliminate whole crayfish populations or, if chronic, reduce crayfish numbers indirectly by altering trophic relationships within the ecosystem (Hobbs and Hall, 1975, Hogger, 1988). Pollution has been reported as being responsible for the reduced distribution of *A. pallipes* in Ireland (O'Keefe, et al, 1983).

There is some evidence to suggest that this species may be able to tolerate mildly eutrophic conditions and indeed research has shown that *A. pallipes* is perhaps more tolerant of elevated ammonia levels than was previously thought. In natural conditions the detrimental effects of pollution episodes on this species may be mitigated by its ability to migrate from shallow, hypoxic water into air and remain there voluntarily for long periods. (John Foster, 1995 and pers. comm.).

A. pallipes is always found in freshwater and there are no records for this species in brackish tidal or estuarine waters.

All the European crayfish require a summer temperature over 10°C and growth of *A. pallipes* is very slow under 10°C (Wintersteiger, 1985 and Pratten, 1980). Apart from this critical summer figure this species appears to have a wide tolerance to temperature conditions. They can tolerate water in localities experiencing low winter air temperatures ranging from -2 to -4°C and high summer water temperatures of 23°C (Pratten, 1980 and Torre et al, 1964). Low temperatures in montane areas for example are less likely to be a limiting factor than the torrential character of some flow regimes.

2.2 Water quantity and flow regime

Most crayfish species are essentially riverine in nature, but most are able to survive equally well in either running or static waters provided the physical, chemical and biological conditions are all suitable (Hogger, 1988). *A. pallipes* is no exception and is able to inhabit a wide range of flow conditions. It has been reported from fast-flowing, small shallow streams less than 0.3 metres depth to deeper slow flowing rivers (Arrignon et al, 1983, Hogger, 1984 and Jay et al, 1981, Duffield, 1933). Thriving populations have also been recorded in lakes and reservoirs.

This species tends to avoid very fast flowing waters with mobile substrate and high solid transport, such as encountered in the mountains. In most rivers and streams they tend to inhabit the margins where refuges and shelter from the current can be found.

It seems that *A. pallipes* is rarely found in perennially dry headwaters, such as winterbourne systems, and at spring heads due to the low mean summer temperatures. Lack of water caused by drought and/or overabstraction can cause problems for crayfish, and unless the population is able to migrate to areas with permanent water then it will be eliminated (Holditch et al, 1995).

2.3 In channel and bank zone habitat structure

Where water quality and flow conditions allow native crayfish to exist their abundance and local distribution is primarily related to the abundance of in-channel refuges, litter and detritus, and a diverse bank structure (Hogger, 1988).

Due to their benthic habit they are highly sensitive to habitat change, particularly when they are subjected to an increase in levels of suspended solids (Westman, 1985 and Hogger, 1988). This species tends to avoid predominantly silted areas, although it will burrow into silt on banks and under stones.

There appears to be a good relationship between the distribution of this species and the occurrence of suitable river and/or stream bed substrate, especially large particle sizes, e.g. cobbles and boulders, and indeed positive relationships have been found between stone refuge size and crayfish body size (Foster, 1993).

In large streams and rivers even where the mid-channel substrate conditions are suitable crayfish will still predominate along the edges and margins. This ecotonal habit probably relates to the abundance of refuges and there is an important link here with the physical structure of the bank, its predominant material and emergent vegetation. In cases where a diverse in-channel habitat is found, including large cobbles and boulders, coupled with a complex physical bank structure, this is where crayfish populations will reach their greatest density and most varied age structure (Hutchings, 1996).

The architecture of the channel banks, the presence of bankside trees and shrubs and the extension of their roots into the water has a major influence on the abundance of *A.pallipes*. Recent work has shown that three important bank-zone factors have a strong positive relationship with crayfish abundance, these are the proportion of vertical bank present, the proportion of channel width overhung by plant canopy that was more 0.5 metres above the water surface and the proportion of bank length with tree root systems projecting into the water (Smith, et al, 1996).

The structural complexity of tree and shrub roots, particularly of alder *Almus glutinosa*, willow *Salix spp.* and hazel *Corylus avellana*, provide refuge from high flows and predation, as well as debris traps retaining leaf litter. Leaves are a primary source of food and calcium for crayfish in many flowing water systems (Momot, 1984 and Goddard, 1988). Thus the combination of riparian vegetation, overhanging roots and vertical undercut banks provides protection and food for crayfish.

Local studies have shown that the warm shallow littoral zone in summer, where this complex habitat exists, are important for all age classes of native crayfish, but especially critical as nursery areas for the first year (0+) juveniles. This bank-stream bed interface assumes greater importance for juveniles after dispersal from adult females in June and July. First year juveniles tend to be prolific and cluster in these areas in August possibly for the enhanced growing conditions of the warmer temperatures in the margins (Hutchings, 1996).

Man-made features in this zone may also provide good habitat for native crayfish. Underwater stone walls, collapsed water-meadow weirs and sluices, bridges and sympathetic bank works, such as willow or hazel faggots and deflectors or groynes, e.g. hazel hurdles, all offer suitable marginal habitat for the species (Rogers and Holditch, 1995).

Consequently, similar to many other aquatic macroinvertebrates, this species tends to be patchily distributed along stretches, and this is primarily due to the sporadic occurrence of suitable substrate and the dynamics of this in-channel habitat mosaic.

2.4 Landuse zone

Given the sensitivity of this species to in channel and bank-zone factors it follows that *A. pallipes* may equally be sensitive to adjacent landuse and general catchment conditions. Semi-natural habitats contiguous with aquatic systems, such as terrestrial wetland biotopes, eg. unimproved wet grassland, fens and alder carr, may enhance the habitat potential for this species. Complex habitat systems and gradients across the floodplain, such as those which include greater tussock sedge *Carex paniculata* colonised water meadows, may harbour remnant native crayfish populations.

Recent work has suggested a link between stocking levels and grazing pressure and the occurrence of crayfish populations. On the River Piddle few native crayfish have been found in unfenced sections, yet in fenced-off stretches it appears to be abundant (David Summers, pers. comm.). Local work on the River Itchen however has shown that native crayfish can be found in both grazed bank sections as well as fenced areas, this is perhaps an area which requires further investigation (Hutchings, 1996)

Generally *A. pallipes* can be described as a good indicator of the ecological status of a catchment given the species' sensitivity to changes in water quality, the siltation process and habitat modification and disturbance.

3.0 The distribution of *A. pallipes*

3.1 Worldwide distribution

This species is confined to the European continent and the British Isles (Figure 3).
In a world-wide context the indigenous European crayfish fauna is relatively limited with only five species, contrasting for example with the USA which has approximately 100 species and Australia with around 300 species. This distinct European group all belong to the family Astacidae.

3.2 European distribution

Holditch and Lowery (1988) deal with the distribution and ecology of the five European species in some detail.

The activities of man are thought to have extended the range of some species before translocations were documented, it is therefore impossible to know what represents their natural ranges. The distribution of these species in Europe has probably stayed the same for the last 140 years, yet their density in most areas has decreased due principally to the spread of the crayfish plague, but also through pollution and waterway management schemes (Holditch and Rogers, 1996). All native European species are susceptible to this disease and in some areas of Europe populations have been decimated and are only now represented in isolated pockets missed during the spread of the plague.

A. pallipes is no exception to this, but was still regarded as being widespread in Europe a decade ago (Laurent, 1988). Its distribution covers Western Europe from 56°N in Great Britain south to 38° S in Spain, and from 8° W in Ireland to 16° E in the Balkan peninsula (Figure 3). No firm information exists generally about its current status and distribution in Europe.

3.3 National distribution

The distribution of this species is reflected in its legal status. This species is listed in Appendix III of the Berne Convention and Annexes II and V of the EU Habitats and Species Directive, and is considered to be an endangered species in Europe (IUCN Red Data Book, Groombridge,1993). It is protected under Schedule 5 of the Wildlife and Countryside Act, 1981 in respect of taking from the wild and sale. A national action plan has also been prepared for this species and presented in "Biodiversity: the UK Steering Group Report" (Palmer, 1995).

Recent work has shown that at a national level *A. pallipes* is still widely distributed (Figure 4) (Holditch and Rodgers, 1995). *A. pallipes* is widespread in England, present in some parts of Wales and is probably naturally absent from Scotland.

The origin of *A. pallipes* in the British Isles is uncertain. Three possible origins have been put forward; the species may be a glacial relict from before the last ice age, or it has since colonised British waters from mainland Europe, or it has been introduced by man at some stage in the past. Recent research has enabled the separation of mitochondrial DNA in several organs of crayfish species, a process which up until recently has been difficult, and should lead to more information on the genetic variability within and between populations (Souty-Grosset and Grandjean, 1996).

Despite this apparent widespread distribution in Britain, at a local level many populations recorded prior to 1990s have not been reconfirmed in recent surveys as seen from a comparison of open and closed circles on Figure 5 (NB. This figure should be viewed with some caution, see below).

In many cases the reasons for the apparent absence of crayfish may simply be due to the inherent problems of sampling for this species, or lack of upto date information. Their absence from surveys does not necessarily mean that they have disappeared from a site. Holditch and Rogers report in their recent work that some populations represented by open circles in Figure 4 may still be extant, yet many populations known during the period 1970 - 1990 have not been confirmed. This is partly due to the impact of crayfish plague, particularly in central and southern England and eastern Wales (Holditch and Rogers, 1995).

The publication of the NRA crayfish identification leaflet in 1994 and the increasing interest in this species have generated more information on the distribution of *A. pallipes*, but the analysis of trends in this data is at an early stage. New distribution maps for this species should be published by ITEs Environmental Information Centre sometime in 1997.

4.0 Historic records of *A. pallipes* and associated habitats in Hampshire

Few documented records exist for this species and its associated habitats in Hampshire before the 1980s.

Most information appears to relate to the River Itchen and Hampshire Avon populations, the former long being regarded as a stronghold for this species in southern England. One study in the early 1980s for example, found that 27% of trout diets in the River Itchen contained crayfish, indicating that this species was widespread in the river (Frake and Frayling, 1984).

The ITEs Biological Records Centre has only three confirmed sightings of native crayfish from the 1980s. The first on the Wallop Brook a tributary of the Test in July 1989 and the second on the Itchen at Alresford and lastly from the Tichbourne Brook in June 1991.

Reports from NRA fisheries personnel confirmed the presence of native crayfish in the main River Itchen from Woodmill near the tidal limit upstream to Drove Lane, Alresford, along some 20 km of river and associated backwaters from 1987 to Spring 1990 (Foster, 1993). Similarly NRA Biological surveys recorded this species near Abbotstone and Itchenstoke in 1990 and these were confirmed again in 1994 by John Foster (Foster, pers. comm.).

Much of the evidence for this species appears to be anecdotal however, with reports of *A. pallipes* from all the main catchments in Hampshire, i.e. the Rivers Test, Itchen, Hampshire Avon, Meon and some of the New Forest streams.

Much evidence of *A. pallipes* in rivers has appeared as a result of populations being affected by the crayfish plague. Aberrant behaviour due to infection by this disease has made this species more conspicuous to onlookers and as such has given some good distribution information, albeit historic data on probably now extinct populations.

In 1984 for example the *A. pallipes* population in 65 km of the Hampshire Avon was eliminated by this disease within two months of an initial mortality. Similarly there were many reports by waterkeepers and others on the Itchen in the early 1990s of mass mortalities of large numbers of

native crayfish. Some reports suggest a catastrophic decline and others a phased decline over a period of months and possibly years, the latter probably reflects the nature of spread of this disease through the convoluted waterways of this system rather than a small dispersed population.

In the past *A. pallipes* was widely distributed throughout many catchments of the Thames basin, including those streams which rise on the chalk in Hampshire, eg. the Loddon and Whitewater. In 1981 a mass mortality of this species was observed and *A. pallipes* disappeared from both streams. Crayfish plague was suspected as the cause but unconfirmed in both cases. Recent reports (1992) suggest a remnant population of *A. pallipes* along the Hants/Berkshire border in the Loddon catchment at Ramsdell, but this is yet to be confirmed (Martin Moore, pers. comm.).

It is interesting to note that there appear to be no reports from the River Test of such mortalities. Yet early implants of signal crayfish in the 1970s has led to a well established wild population in the main river and tributaries (see below), so perhaps it is not surprising that few native crayfish have been seen since that time.

As far as can be ascertained no current or historic information on this species exists for the Isle of Wight (Colin Pope and Roger Herbert, pers. comm.).

Figure 5 shows the distribution of *A. pallipes* in the southern region up to 1994 at the 2 km square level.

5.0 Population trends in Hampshire

5.1 General trends

The decline of A. pallipes populations is well documented in the British Isles (Holditch and Reeve, 1991 and Holditch et al, 1995). These studies provide evidence to suggest that *A. pallipes* populations in the British Isles were stable and extensive until the 1980s. Before this date various workers have reported large fluctuations in numbers at some locations (Duffield, 1933, 1935, Pixell Goodrich, 1956), but it has been proposed that these were probably caused by a combination of changes in water quality, drought, habitat modification and disease, such as Thelohaniasis or porcelain disease (Holditch et al, 1995). There is little evidence to suggest that the crayfish plague was the cause of these earlier changes, yet here is substantial evidence since the 1980s. Non-native crayfish species are gradually increasing their range and in some river systems causing widespread loss of *A. pallipes*.

5.1.1 Hampshire

The Hampshire population of *A. pallipes* has without any doubt undergone a dramatic decline over the last ten years. The scale of this change is difficult to ascertain due principally to the lack of baseline information.

There is substantial anecdotal information on the distribution of this species generally but the reliability of such is hard to ascertain. The River Itchen for example, has been regarded as a stronghold for this species but with few confirmed sightings. Waterkeepers have reported this species throughout the full length of the Itchen system from the 1980s to the early 1990s. It is impossible to estimate populations from this information, but despite a probable patchy distribution along the river, individuals may have totalled several hundred thousand. Today the population is

estimated at a maximum of 2,000 individuals and recent surveys have shown this population to be in decline (Hutchings, 1997).

The causative factors involved in the decline of this species locally are difficult to identify, apart from the Hampshire Avon where the crayfish plague has been confirmed. However there are several factors which potentially have led to the observed population trend, these include:

- crayfish plague
- habitat and landuse change
- changes in water quantity
- impacts of river management practices and predation

5.2 Causal factors

5.2.1 The crayfish plague in Hampshire (the fungus *Aphanomyces astaci* Schikora)

Crayfish plague has been the single-most important factor nationally in causing widespread mortalities of *A. pallipes* in the 1980s and 1990s. This also holds true for Hampshire, yet it is only on the Avon that this disease has been officially confirmed (by David Alderman of MAFF in Frake and Frayling, 1984). The probable outbreaks of plague on the Rivers Test, Itchen, Meon, Loddon and Whitewater have never been confirmed despite individual crayfish being tested. One of the problems in isolating this disease is the incidence of secondary fungal and bacterial invasion masking the evidence of plague. Ideally specimens for analysis should be freshly dead or even moribund to identify this disease.

5.2.1.1 History of introduction in the UK

The history of crayfish plague outbreaks is well documented in England and Wales up until 1992 (Alderman 1993), and the first positive records for the disease were made in the Bristol Avon and River Lee catchments in 1981 (Alderman et al, 1984). At an early stage in the spread of this disease the signal crayfish *Pacifastacus leniusculus* Dana was proved to be the main vector for the fungus *Aphanomyces astaci*, the causative agent of crayfish plague (Alderman et al, 1990).

Originally implanted into crayfish farms in southern Britain signal crayfish have subsequently shown a large increase in distribution with most catchments having farmed or wild population of *P. leniusculus*. The number of registered crayfish farmers has risen by almost one third compared with the situation in 1989 (Holditch and Reeve, 1991).

Wild populations are steadily increasing in number and range, and deliberate introductions and escapes have given rise to at least 40 wild riverine populations in Britain. The Rivers Test and Avon are good examples of this, and on the Test alone there are at least two signal crayfish farms. The exact number of MAFF registered crayfish farms in Hampshire is difficult ascertain, as this information is not in the public domain.

5.2.1.2 Biology of the fungus

The fungus itself is spread by actively swimming zoospores which are released in large numbers from heavily infected and dying crayfish. The length of survival generally varies from 4 to 40 days, and spores remain viable from 6 to 22 days depending on the water temperature (Alderman et al, 1984, Matthews and Reynolds, 1990).

North American species, such as the signal crayfish appear to have a exoskeleton which is more resistant to hyphal penetration, and may even be able to kill it. At times of moult and other stress *P. leniusculus* can succumb to this disease as well and there have been reported mass mortalities of this species in culture and the wild in Sweden (Smith and Soderhall, 1986).

The biology of the crayfish plague fungus is dealt with fully by Smith and Soderhall, 1986 and Alderman and Polglase, 1986, 1988.

5.2.1.3 Method of spread

The method of spread of this disease is of fundamental importance in any discussion of the conservation of *A. pallipes*. This fungus can only live on other crayfish, so if all the crayfish have been wiped out in a river system so should the disease. The spores however survive, and can remain viable and infective, from a number of days to two weeks in water or damp conditions, such as mud, weed or damp equipment (Rennerfelt, 1936 and Matthews and Reynolds, 1990). Predators of crayfish, such as otters and birds may also carry the fungus, the latter possibly on their plumage, feet or as whole crayfish (Slater and Rayner, 1993). Laboratory experiments have shown that fish can also transfer this disease from one water body to another (Alderman et al, 1987).

The spread of this disease is therefore difficult to control especially downstream. There have also been cases cited of the disease moving upstream at reported rates of 2 - 4 km per year (Alderman and Polglase, 1988).

5.2.1.4 Control measures

There would appear to be no control measures for this disease once it has entered a river system, but chemical decontamination methods to sterilise equipment do appear to be effective. The effectiveness of all decontaminates is negated however if equipment is not clean of debris and mud (Alderman and Polglase, 1985). Drying is also effective, but logistically difficult especially when moving between sites over a short time period. Disinfection of survey and fishery equipment, eg. electro-fishing gear, survey nets, waders etc. would appear to be essential in this situation.

5.2.2 Habitat/landuse change

The impacts associated with habitat modification and loss are of prime importance in the distribution and in some cases the survival of crayfish.

There are two principal aspects of the management of water bodies which can be detrimental to crayfish populations:

- alteration of the prevailing physical characteristics and habitat modification
- changes in chemical water quality

Crayfish are highly sensitive to habitat change and this is due principally to their slow-moving, benthic habit. Dredging, resectioning and general channel modification works can have a dramatic effect on abundance of crayfish, either through direct physical removal of individuals and habitat or indirect changes associated with siltation and water quality changes (Westman, 1985). Removal of favourable habitat features such as stones, vegetation, steep banks, bankside trees and shrubs,

bottom fauna and organic deposits usually results in the remaining population being smaller than that present prior to such works (Niemi, 1977).

There would appear to be no significant trend in the incidence of similar works in the county. The Environment Agency's precautionary approach to applications for such works and SSSI/SAC status of many stretches may mean more sympathetic treatment of channels and banks in the future.

There are however many examples of work unsympathetic to crayfish and macroinverteberates generally along the Hampshire streams. Channel narrowing works for example, where geotextiles have been used to shore-up banks, and resectioning activities which have overdeepened and modified the gradient of streams are still widespread and may impact on native crayfish if present. One of the sites of the few remaining native crayfish colonies still existing was severely dredged three years ago, with many of the larger chalk flints removed, and when a whole section of the Candover Brook was realigned in the late 1980s hundreds of native crayfish were left high and dry, many being rescued and transferred to alternatives sites. On the main Itchen new sheet piling revetment work near Itchen Abbas exposed a population of native crayfish in 1992, but recent surveys revealed no crayfish at this site (John King, pers. comm.).

Increasing siltation which has been observed in many middle and lower stretches of Hampshire catchments, for example in the River Test, could have contributed towards the decline of this species. This species tends to avoid silt dominated substrate and in some cases it can act as a barrier to both upstream and downstream migration (Hutchings, 1996). The link with adjacent landuse change in this respect is an important one, for example the last 30 years has seen significant changes in agricultural practices, the move from permanent pasture to arable being one of the most relevant in relation to the siltation issue.

Drastic changes in landuse adjacent to streams, including intensification of existing practices and perhaps in some cases increased abstraction of ground water, could impact on native crayfish populations if present.

Changes in water quality, including diffuse and episodic pollution events, are one of the main threats to crayfish survival (see Section 2.1), although there is no evidence to suggest that such trends have contributed to their decline in Hampshire streams. The limited distribution of this species in Hampshire makes them highly vulnerable to one-off pollution events.

5.2.3 Changes in water quantity

Any small or large-scale changes in the hydrological regime of rivers, especially of small stream systems, can result in some form of channel impact, including lower flows and more frequent drought conditions, the potential of concentrated nutrient loading and siltation. All of the above have been shown to alter crayfish populations directly or indirectly by changing trophic relationships within a stream and may be causative factors in the decline of *A. pallipes* locally.

It is interesting to note that both the Candover Brook and the River Alre, where the two native crayfish populations still exist in the Itchen, have licenced water abstraction and stream augmentation schemes and are systems which have suffered from low flow problems in the past.

Climate change may be a significant factor in the decline of this species.

5.2.4 River management practices and predation

Whilst many fishery management practices are sympathetic to macroinvertebrate habitat, there are some activities which may have impacted on this species. These include over stocking with rainbow trout, electro-fishing, fish transfers and loss of bankside habitats, such as trees, shrubs and emergent vegetation.

Of these, two deserve particular attention. An extreme example of overstocking and one which may have had a massive affect on local populations in the River Itchen occurred in 1989. At this time approximately 43,000 ten ounce rainbow trout are reported to have escaped from a hatchery in the middle part of the River, of which three or so tonnes were still in the Itchen during the survey period (Foster, 1993). Such a population of trout could have exerted an excessive burden on native crayfish to the extent of influencing population dynamics and especially recruitment. It is unlikely however that predation by fish would eliminate a native crayfish population, but in combination with over factors, such as diffuse pollution, it may have caused a significant decline.

Interestingly in all the existing native crayfish sites it is possibly the Candover Brook and the Bartley Water that remain rainbow trout free. Wild salmonid fisheries can still be found in the upper sections of the Itchen, Test and Hampshire Avon, but most now also contain rainbow trout.

Importation of fish from crayfish plague infected catchments, such as the Hampshire Avon and the River Test, could directly lead to the introduction of the spores from this fungal disease (see Section 5.1.1 above). The likelihood of transferring this disease are high, where for example the fish are taken from a stretch which has recently dead or dying native crayfish. Actively sporulating crayfish will release millions of spores into the river and fish will transfer them in their gills and slime. Conversely the probability appears to be low where native crayfish have been eliminated some time ago, the River Test for example where the plague probably first hit in the 1970s (David Alderman, pers. comm.). Both rainbow and brown trout are transferred from hatcheries on the Test to other rivers in the county.

It is also important to note that aquatic mammals and birds can transfer this disease as well as predate crayfish. Otters and mink actively take native crayfish and where abundant can form a large proportion of their diets, and equally the former, a species with a large territorial range, could potentially be a significant vector of the crayfish plague. The recent expansion of the local range of this species, aided by the reintroduction project, and possible movements of individuals across catchments could be an important factor in the long-term survival of native crayfish.

6.0 Current status

6.1 Distribution of *A. pallipes* in Hampshire

The current known status of *A. pallipes* in Hampshire is shown at the 1 km square level in Figure 6. Known populations are confined to the Rivers Test, Itchen and the Bartley Water, New Forest. In the County and in the Southern and Wessex Regions (Environment Agengy) the status of *A. pallipes* is endangered, as a species which has been seriously depleted to critical levels and whose future is unlikely if the causal factors continue to operate (IUCN, 1989).

Recent work in local rivers has shown this species to be restricted to four sites (Hutchings, 1996 and 1997, and John Gulliver, pers. comm.). The locations are:

The River Itchen:

- the Candover Brook at Fobdown Farm (GR SU 571338)
- the River Alre at Drove Lane (GR SU 577327)

The River Test:

the River Anton at Upper Clatford (GR SU 361426)
the Bartley Water in Busketts Inclosure (GR SU 324105)

The Candover Brook population

An apparently healthy, yet small population and the most researched in Hampshire. This population, confirmed in 1995 by the author, has been closely monitored for the last two years and appears to have slightly expanded it's range both up and downstream during this time. Population studies have shown this site to hold approximately 2,000 individuals, which are confined to a 300 metre stretch.

This stretch flows adjacent to a watercress farm at Fobdown and as such is unfished. Although there is no direct link between the cress beds and the stream, water does return from settling ponds at several locations along the stretch. The staff at the water cress farm manage the channel where the crayfish are found.

The River Alre population

A recently confirmed find (Hutchings, January, 1997) of a potentially very small relic colony. This site requires further investigation in Summer 1997. The population is confined to a short, lightly fished stretch, comprising characteristic wild salmonid and classic crayfish habitat (see section 2.0 above).

The River Anton population

Another potentially small population, which is probably the most threatened of all remaining colonies. A lake above the stretch unconnected with the main stream is reported to contain signal crayfish, whilst downstream in the main river this species has also been observed. It would appear that pure luck has enabled the survival of this population.

The section is relatively unmanaged and is found flowing along the bottom of several private gardens. Again classic crayfish habitat can be observed here with overhanging trees and complex bank and channel bed structures.

The Bartley Water population

Observations by John Gulliver, New Forest Keeper, suggests that native crayfish can be found mostly in the middle sections of this natural stream system. It is likely that this species is confined to debris dams along the stream which rises north of Lyndhurst and enters Southampton Water directly at Eling Tide Mill. The population needs further research in Summer 1997.

This find is interesting on a number of counts. Firstly it may represent one of a number of relic New Forest populations and indeed the upper Beaulieu and Cadnam streams could also hold native crayfish. Secondly because of its isolation from the River Test it is relatively well protected from crayfish plague and may be the last relatively natural population left in southern England.

6.2 Distribution of signal crayfish, *P. leniusculus* in Hampshire

As the main vector of the crayfish plague it is essential to investigate the status and distribution of this species in Hampshire. Figure 7 gives the state of knowledge regarding the distribution of this species in the southern region upto 1990. Wild populations of signal crayfish have been reported from the catchments of the Rivers Test, Hampshire Avon and Meon. In each of these areas there are well established signal crayfish farms. The River Test for example has at least two farms, one in the north near Andover which is a semi-intensive system, whilst the farm near Romsey is run as a wild ranching concern. There are other interested individuals on the Test who harvest this species from the wild on an occasional basis.

There is no evidence in Hampshire to suggest that this species co-exists with *A. pallipes.* There are at least two populations in England where a plague-free signal population can be found alongside native crayfish, but there have been no such reports in this region.

From surveys and reports over the last two years the current state of knowledge of this species at the 2 km square level in Hampshire is given in Figure 8. It is unknown whether signal crayfish are expanding their range in Hampshire.

7.0 Comment on the state of knowledge of Native Crayfish in Hampshire

The state of knowledge of native crayfish up until 1995 was poor, many records being old or unconfirmed. The Native Crayfish Project, Hampshire initiated in 1995 set out, amongst other things, to improve on the existing distributional information on *A. pallipes* and the signal crayfish.

Two years into this project and the state of knowledge of *A. pallipes* has improved significantly. There are inherent difficulties associated with surveying for this species, including the patchiness of distribution and nocturnal behaviour, and there is always the possibility of finding relic populations.

Enhanced awareness of the plight of this species following media coverage and improved links with riparian owners and waterkeepers, mostly through the Test and Itchen Association, has led to substantial information on both native and signal crayfish in local rivers. The reliability of such is variable, but nonetheless the Native Crayfish Project has acted as a focus for this information.

8.0 Predictions of potential locations in Hampshire

There are a few possible locations where new populations of this species may be found. These locations are limited primarily due to the potential threat from crayfish plague. The greatest potential lies in upper tributaries or sections of rivers, where perhaps the disease has not reached, and where the water is of good quality and the hardness/conductivity are suitable. In these locations it is quite possible that relic populations of *A. pallipes* will be found.

The following list of locations are where these factors come together:

The New Forest streams
the Cadnam stream

The River Test
upper main River, above Laverstoke near Overton
The upper Blackwater above West Wellow

The River Meon
upper River above Warnford

The River Rother
upper River near Petersfield

The Rivers Loddon and Lyde
upper Rivers near Sherfield on Loddon

The Basingstoke Canal
upper stretches near Greywell and the upper River Whitewater

9.0 Current/past conservation work

9.1 Past Conservation Work

9.1.1 Ad hoc Work

Various people along the Hampshire Rivers have shown an interest in crayfish in the past, but unfortunately this has been directed mostly towards the signal crayfish. Few have undertaken any form of conservation work to protect *A. pallipes*.

There are reports of waterkeepers and others moving this species around from the River Itchen to the Test, notably the River Dun and the Bourne Rivulet, but these populations have failed to appear in recent surveys. A small number were moved from the Candover Brook, when a section was realigned, to a ditch running parallel to the River Alre, but again no trace has been found as yet. A small number of native crayfish were transferred from the Candover Brook at the same time and kept at St Marybourne on the Bourne Rivulet in cages, an exercise which appeared to be successful, then released into the stream. Again recent surveys have revealed no crayfish in the Bourne Rivulet.

These well-intentioned translocations were undertaken in ignorance of the legal situation, but tried in an effort to conserve the species.

9.2 Recent Work

9.2.1 National Initiatives

9.2.1.1 Implementation of the "No Go" areas for signal crayfish farms

The Prohibition of Keeping Live Fish (Crayfish) Order came into force in May 1996. The Order prohibits the keeping of all non-native crayfish throughout England and Wales except under the authority of a licence.

MAFF have also designated "No Go" areas in which the keeping of signal crayfish without a licence is also prohibited. Both the River Itchen and all the streams within the New Forest perambulation are included in this designation, yet the River Test, with at least one confirmed native crayfish population, is not included because of the well-established signal crayfish farms in the catchment.

It is too early, as well as immensely difficult, to conclude whether all the above conservation activities have been successful or not. However a recent straw poll of several local ornamental aquatics outlets revealed that many keep non-native crayfish without licences and within a "No Go" catchment. It would appear that there is still much education and awareness work to be done.

9.2.1.2 The Wildlife and Countryside Act, 1981

Under the provisions of this Act anyone who releases or allows to escape into the wild any non-native species would be guilty of an offence. Thus anyone selling crayfish, not only needs a licence under the crayfish Order, but also needs to be careful that they do not escape and should inform buyers of this requirement as well.

The three non-native crayfish species which are established in the wild in Britain - *Astacus astacus Astacus leptodactylus and P.leniusculus* - were added to Schedule 9 of this Act in 1992. It is now an offence under Section 14 of the Act to release these species, or allow them to escape into the wild without a licence, unless" reasonable steps" are taken and "due diligence" is exercised to avoid escape. It is also an offence to release other crayfish of a kind not ordinarily resident in Great Britain in a wild state.

9.2.1.3 Species conservation strategies

Both the NRA and MAFF/JNCC have produced national crayfish conservation action plans (Holditch and Rogers, 1995, and Palmer, 1995). Both are similar in terms of recommendations, indeed information from the former, an NRA research contract, was fed directly to JNCC during its production. There is substantial overlap between the two reports, but they have laid the foundations for the national species action plan for native crayfish.

9.2.2 Local Initiatives

9.2.2.1 The Native Crayfish Project Hampshire

This project was initiated by the Department of Fish, Game and Wildlife Management at Sparsholt College, Hampshire in 1995. The aims of this project are to:

- act as a focus for native crayfish conservation work in Hampshire

- collect and collate information on the distribution of native and non-native crayfish in Hampshire

- implement positive conservation work to protect and maintain *A. pallipes* in Hampshire

Over the last two years the following work has been undertaken or is still on-going in the County:

River surveys completed and monitoring implemented (EA and EN Species Recovery Programme funded):

The main River Itchen, including the Cheriton, Tichbourne, Alre tributaries in 1995

The main tributaries of the River Test, including the Bourne, Anton, Dever, Wallop, Dun and Blackwater streams in 1996

The Monks Brook tributary of the River Itchen in 1996

A monitoring programme implemented on the Candover Brook

Raising awareness and education

Discussions regarding protection and positive conservation work with all riparian landowners in and around native crayfish sites on the Rivers Test and Itchen.

Approx. 80 NRA crayfish leaflets distributed to waterkeepers and landowners along both Rivers.

A report on the project included in both the 1995 and 1996 issues of the Test and Itchen Association annual report.

Database of distributional information

Held at Sparsholt College and data fed to BRC Monkswood and Nottingham University

A Geographic Information System has been set-up to analyse the above information.

River enhancement work (EA funded):

A river enhancement scheme to encourage the upstream migration of A. pallipes in the Candover Brook, January/February, 1997

Native crayfish rearing unit at Sparsholt College (EA funded):

Set up to protect the genetic stock of River Itchen native crayfish, as a security measure for this fragile population found to be declining in 1996. A research unit to investigate the requirements of this species in captivity and the feasibility of restocking.

Working group:

Formed in April 1995 to bring together interested bodies and to develop a strategy for native crayfish conservation in Hampshire.

A local species action plan has been developed.

9.2.2.2 River SSSI notification and possible SACs

Both the River Itchen native crayfish sites are now designated as river SSSIs under Section 28 of the Wildlife and Countryside Act, 1981, and owner occupiers have been informed of the crayfish interest in their streams. The Bartley Water also falls within the New Forest SSSI boundary.

The above sites have also been included in the list of possible Special Areas for Conservation under the European Habitats and Species Directive: Natura 2000. *A. pallipes* is listed in both Annex II and V of this Directive, requiring member states to designate SACs for its conservation.

10.0 Potential future opportunities

There are several areas where potential future opportunities to assist the conservation of this species are evident, these are:

10.1 Survey and Monitoring

There are many opportunities to enhance the existing distributional information on this species through survey of sites identified in Section 8 above. Monitoring of existing native crayfish populations and the establishment of new monitoring programmes for all newly identified native and selected signal crayfish sites is equally important.

10.2 Education and information

A substantial amount of work has already been done in this area, particularly with riparian owners and waterkeepers, yet it is apparent that there is much still to do. The ornamental aquatics trade locally for example, could be targeted for special attention.

A locally produced information leaflet is required to raise the level of awareness of this issue and to publicise the need for conservation and how the public can help in sending in records.

10.3 Enforcement and monitoring the law relating to *A. pallipes* and non-native species of crayfish in Hampshire.

There is some debate nationally as to which Government Agency is best placed to enforce and manage the recent MAFF Order and various crayfish conservation actions plans (JNCC and NRA). It is essential to clarify the situation locally given that the River Itchen catchment and the New Forest are two of the few "No Go" areas in the southern counties. A great opportunity exists here to be one of the first Regions to effectively deal with this issue.

MAFF should also be consulted regarding the designation of further "No go" zones in the County, although the feasibility of such is limited due to the probable widespread distribution of signal crayfish. There may also be scope to improve the availability of information on MAFF licences for signal crayfish farms and to revoke unused licences (after a specified period).

Similar opportunities exist through the Environment Agency to more strictly control the transfer of fish, particularly rainbow trout, from plague-infected catchments, and to actively encourage the maintenance and enhancement of the wild salmonid fisheries in the middle and upper stretches of the Hampshire chalkstreams.

10.4 Site Safeguard

Whilst most identified native crayfish sites have now been designated within the River SSSI system (apart from the River Anton), there would appear to be further opportunities at a site level to protect this species, for example by enhancing crayfish habitat and ensuring that all channel works are sympathetic. Proposals for the latter at or close to known native crayfish sites should be scrutinised for their potential impact on this species through consultation with the Native Crayfish Project, Hampshire.

This work could include the development of site specific species management plans or the designation of sensitive crayfish zones. In this respect ecologically acceptable minimum flows and water quality identified by the Environment Agency should be maintained at all known native crayfish sites.

10.5 Habitat enhancement schemes

Some species specific enhancement work has already begun on the River Itchen, but there remains alot of scope for further projects in all known native crayfish sites, and indeed any river enhancement scheme being undertaken on local rivers. It takes little extra cost to incorporate habitat features into new schemes which could be beneficial to native crayfish and macroinvertebrates generally.

Targeting further habitat management and enhancement work in-channel and on land adjacent to known sites, including arable buffer zones and adoption of the Countryside Stewardship Scheme, would benefit this species.

The production of a booklet on habitat management guidelines for this species may be useful.

The restoration of natural fluvial processes and features along the Hampshire rivers generally and more specifically in known native crayfish sites should be an overarching conservation objective in the County.

10.6 Captive breeding and restocking

Recent surveys have revealed the precarious state of the remaining native crayfish populations in Hampshire and the need to establish the significance of, and if necessary protect the local genetic stock of *A. pallipes* is of paramount importance.

The rearing unit based at Sparsholt College has been approved by the Environment Agency and English Nature and is the first of its kind in the UK. Research into captive breeding methods for this species are essential for the long term survival of the Southern, and possibly the National, genetic stock. This work has nation-wide implications and may lead the way for similar projects in the future.

There may also be opportunities for a restocking programme in the long term. The IUCN guidelines for reintroductions would have to be fully complied with, including a feasibility study phase. Suitable habitat and a disease-free river/stream and access to source of individuals are factors which have to be considered before such a programme could begin.

10.7 Eradication and control of non-native species research

It is commonly agreed that it is impossible to eradicate an established signal crayfish population from a river system (Holditch and Rogers, 1995). Some opportunities may be present in local streams to research control and eradication methods. Discrete and well-defined signal populations are apparent in some streams, eg the River Dever, and these would lend themselves to research.

There are perhaps some opportunities also to ensure that no further implants and wild populations establish in Hampshire waters. As some native crayfish populations exist outside of "No go" areas it should be asked whether it is appropriate for such a development in the first place (see Section 10.3 above). There have been cases where signal crayfish farms have been approved outside of "No go" areas, but where native crayfish are still found, with predictable results.

MAFF should ensure that crayfish farmers are given advice on best practice and containment methods, for example extensive ranching systems should not be sanctioned since it is impossible to contain crayfish in this situation. Ideally crayfish farms should be small enough for containment measures to be effective with no inflows and outflows. New sites should be subjected to risk assessment, particularly those near *A. pallipes* populations and close to links with adjacent "No-go" catchments. MAFF should encourage and assist the establishment of sources of disease-free signal crayfish and stocking should only be done with animals from these sources. The use of disease-free stock should be a condition of a holding licence under the Import of Live Fish (England and Wales) Act, 1980.

11.0 Current conservation issues (threats and opportunities)

This a complex conservation issue which has local and international implications and these are dealt with fully in Holditch and Rogers, 1995. The main conservation issues in Hampshire have been dealt with above, but can be summarised as follows:

11.1 Threats:

- Introduction and spread of crayfish plague (*Aphanomyces astaci*), principally by the signal crayfish (*Pacifastacus leniusculus*) and other vectors.

- Spread and competition from non-native crayfish species

- The spread of non-native crayfish farming outside of "No go" areas

- Modification of freshwater habitats and change in bank and landuse zones

- The threat from episodic pollution events and long term water quality changes

- The inability to enforce and manage the recent legislative initiatives and lack of resources at a national level to fund UK biodiversity action plans

- Overstocking of fisheries and impacts of predation on small, relic native crayfish populations.

11.2 Opportunities:

- positive conservation work, inc. habitat management, captive breeding schemes and raising public awareness

- site safeguard opportunities, both voluntary and statutory.

- improvement of links between conservation bodies and those who manage the Hampshire rivers and streams - the native crayfish as a flagship species.

- research into captive breeding and restocking opportunities.

- increasing interest in this species through media and education initiatives

- training initiatives with EA biological survey/fishery/engineering staff and others involved in survey work for this species.

- to strictly control the establishment of new signal and other non-native crayfish farms outside of "No-go" areas, to provide advice on effective containment and culture methods and to encourage MAFF to establish and utilise disease-free stocks of signal crayfish.

12.0 Discussion

The native crayfish issue is a complex one, requiring national/governmental action as well as regional and local work to ensure the future stocks of this species. It is only recently that interest in *A. pallipes* has emerged and as such very little active conservation work has been undertaken for this species.

One reason is that there would appear to be little that can be done to protect this species in rivers. The means of enforcing and managing the legislation (WCA 1981, MAFF Order, 1996) and the various species action plans are not in place at this point in time. There are inherent difficulties of policing these initiatives in riverine systems and the question "who will do it?" is paramount. The resources appear not to be available to fund much of this work at a national level, including essential research into eradication and control methods for non-native species and close monitoring of signal farms by MAFF inspectors. There is therefore a great opportunity at a regional level to move on this issue and provide the mechanisms to enforce these national initiatives, perhaps embedded in catchment management plans and LEAPs.

In contrast to the national scene there is substantial scope at a local level for action. The relatively small-scale activities of the native crayfish project at Sparsholt College have shown that local initiatives, either voluntary or low budget, can actually have an effect, by for example increasing awareness as well as putting in place positive action within rivers. The latter represent a good vehicle for promoting native crayfish conservation.

There is a dilemma here though, whilst it is important to galvanise local action there is a danger of accidentally losing native crayfish stocks by transferring disease. The more people are involved in this work, perhaps rapidly moving between sites and undertaking in-channel surveys, the greater the likelihood of transferring crayfish plague. The licensing system needs to be strictly controlled for this species and every effort should be made to disinfect and sterilise equipment during survey and other works on the rivers concerned. The means to achieve the latter may be difficult for some and could lead to complacency.

The greatest threat to this species is probably not from survey work however, but from the introduction of non-native crayfish and/or through other vectors of the fungal disease.

Whilst the ideal would be to refuse proposals for new signal crayfish farms outside of "No-go" areas, it may be difficult to achieve in reality, due to the already established signal populations in the wild. Substantial scope exists however to educate and inform current and future farmers of the issues involved in the conservation of native crayfish. The establishment of disease-free stocks of non-native crayfish, coupled with effective containment measures and long term signal crayfish eradication programmes may result in some form of control. The inherent difficulties and inefficiency of current control methods, trapping for example, may mean that such efforts as noted above will be futile. The long term survival of *A. pallipes* may lie with the development of some form of biological control mechanism and the evolution of disease resistance in native crayfish. There would appear to be little hope in this direction at the present time.

There is substantial interest in this species amongst waterkeepers and riparian owners. All native crayfish sites, apart from the Bartley Water, are in private ownership and many owners/occupiers pride themselves in the knowledge that they have this species. There is a good link between wild salmonid fisheries and the existence of native crayfish populations, in the upper Itchen for example, and this is something which should be continually emphasised and promoted. The links between the

fisheries and conservation bodies can only improve with the continued, and hopefully enhanced, presence of this species in Hampshire streams. *A. pallipes* is synonymous with clean and healthy chalkstream ecosystems and as a "flagship" it has tremendous value.

13.0 Conclusion

In the British Isles the native crayfish is widely distributed, yet the species has undergone a dramatic decline in the southern counties and is regarded as endangered in the Hampshire area. The reasons for this decline are hard to ascertain, but is most probably due to the introduction of the non-native signal crayfish, which is the main vector of the fungal disease *Aphanomyces astaci*. This disease is lethal to the native crayfish and can eliminate the species from whole catchments. Other reasons for the decline in Hampshire could also include habitat change, river management practices, low flows and pollution.

The opportunities to protect this species would appear to be limited and hinge on the enforcement of the various statutory instruments, something which at present is almost impossible to achieve. Local action to educate and increase awareness of the plight of this species and its main threats is essential, and coupled with positive conservation measures at a site level could lead to the continued survival of this species in Hampshire.

Annex 1

Recommendations for future work and action

Future Work	Approx. Costs in £s	Priority (low, med, high, v.high)
Knowledge of distribution		
Survey		
Surveys of upper Meon, upper main Test and the Bartley Water	2500	High
Surveys of selected New Forest Streams	2500	High
Site-specific visits to the upper River Loddon, Lyde, Rother and Basingstoke Canal. Liaise with EA Thames Region.		High
Monitoring work on existing populations		
Detailed monitoring of species and habitat requirements at the Candover Brook site	2000	Very high
Monitoring of all *A. pallipes* sites	1500	Very high
Investigate feasibility of long term monitoring on the Bartley Water as a special case	nil	High
Database		
Continue to collate records on all crayfish species in the County	nil	High
Education and Information		
Produce a native crayfish conservation leaflet at the national level, able to be modified at the EA regional level.	2500?	Med/high
Training course for EA, EN and others engaged in biological surveys and river management within the EA Southern Region.	?	High
Target aquatics trade locally to increase awareness of *A. pallipes* and MAFF Order	?	Med/low
Develop a handbook for crayfish habitat management. EA to discuss at national level.	?	Med/low
Site and Species Safeguard		
Develop catchment-based strategies for the conservation of native crayfish in		

Hampshire	?	High/V High
River SSSI in place for most *A. pallipes* sites, investigate SAC designation	nil	Medium
Liaise riparian owners/occupiers/ waterkeepers/Test and Itchen Assoc. re. site safeguard for this species	?	High
Develop site-specific management plans, Candover Brook as initial model	?	Medium
Water quality and quantity monitoring at all *A. pallipes* sites	?	High
Enforce the MAFF "No-go" Order 1996 and practice a precautionary approach to new signal farms outside of "No-go" areas	nil	Very high
Investigate the feasibility of extending "No-go" areas and revoking unused licences for signal farms. EA to discuss with MAFF at a national level. This constitutes part of a section 50 review under the Conservation Regulations 1994 and is a statutory duty.	?	High/V. high
Improve availability of information on existing non-native crayfish farms.	nil	High
Undertake habitat enhancement at, and up- and downstream of, selected native crayfish sites.	?	High
All river enhancement schemes to take account of requirements of this species	nil	Med/high
Retain site confidentiality and control licensing of crayfish surveyors and workers in Hampshire, to minimise disturbance and the chances of infection. EN to liaise with SCH NCP.	nil	Medium
Encourage the maintenance and development of new wild salmonid fisheries in local rivers	?	Med/high
Encourage research on eradication/control measures for non-native crayfish species. EA to discuss at a national level	?	High
Captive Breeding and Restocking		
Research captive breeding requirements of this species and continue the development of the rearing unit at SCH.	£1000 annually	Very high
Encourage research into the genetic variability of native crayfish, as a prerequisite of restocking/reintroduction programmes at national and local levels. EA to discuss at a national level	?	Medium
Undertake a restocking feasibility study (in accordance with IUCN guidelines)	?	High
Implement restocking/ reintroduction activities if agreed through the above feasibility study	?	Med/low

Key to organisations:

EA Environment Agency (Southern Region), EN English Nature, HWT Hampshire Wildlife Trust, MAFF Ministry of Agriculture, Fisheries and Food, SCH NCP Sparsholt College Hampshire Native Crayfish Project

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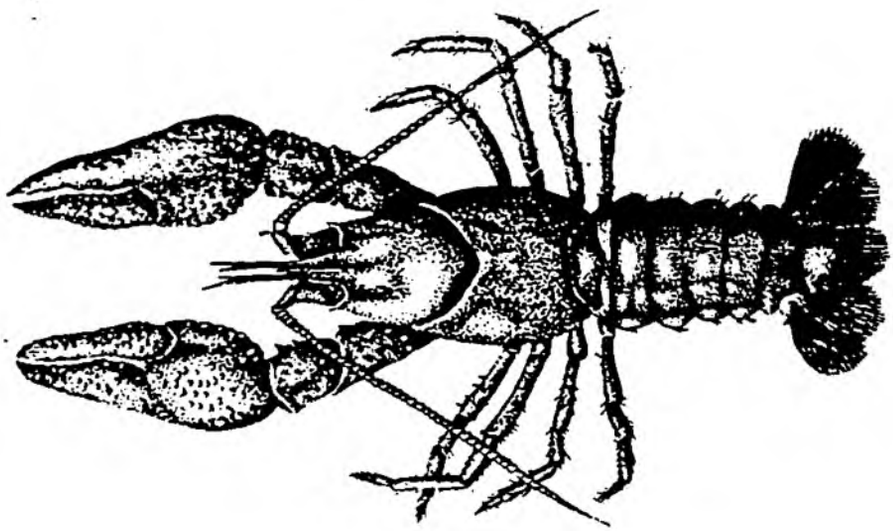

Figure 1. The White-Clawed or Atlantic Stream Crayfish, Austropotamobius pallipes

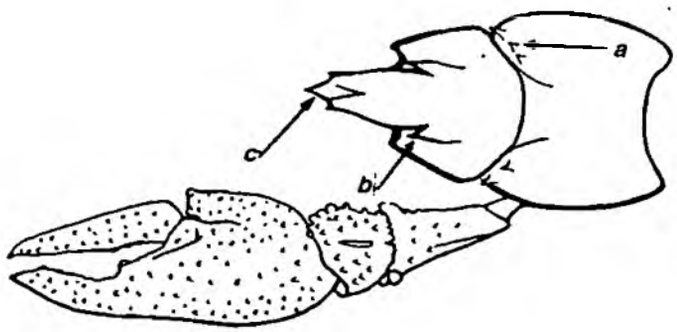

Figure 2. Detail of carapace and chelae. (a: prominent spines behind the cervical groove, b: the single pair of post orbital spines or ridge, c: the apex of the rostrum)

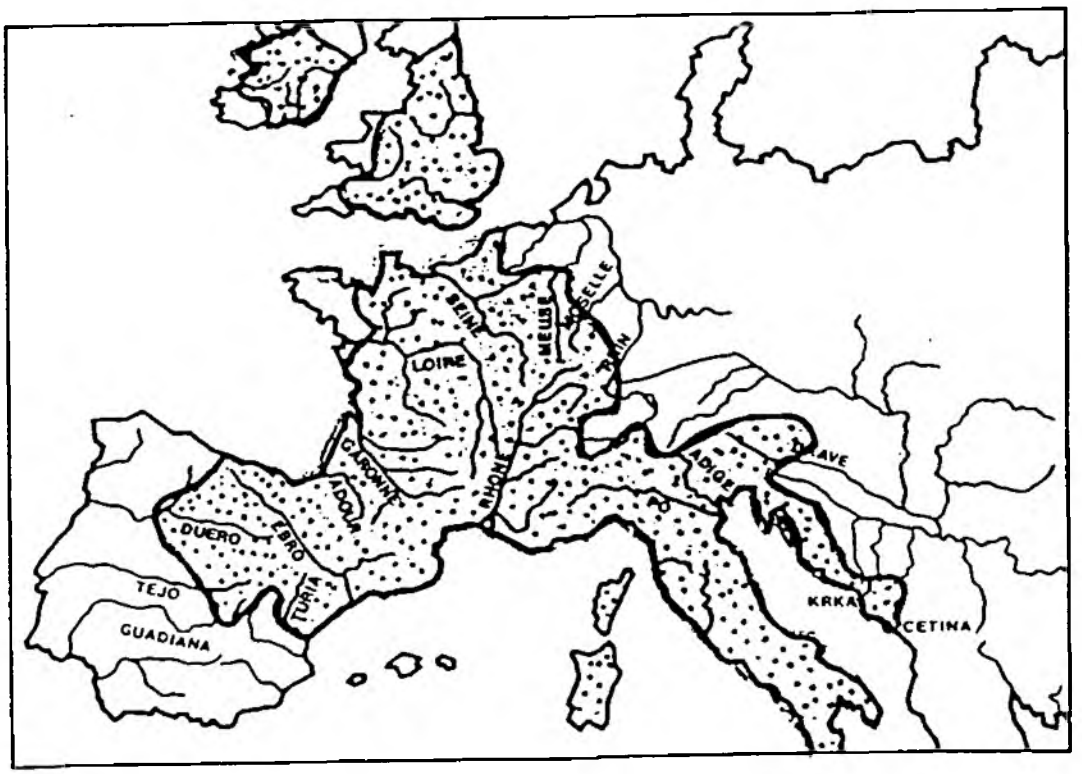

Figure 3. The European distribution of *A. pallipes*

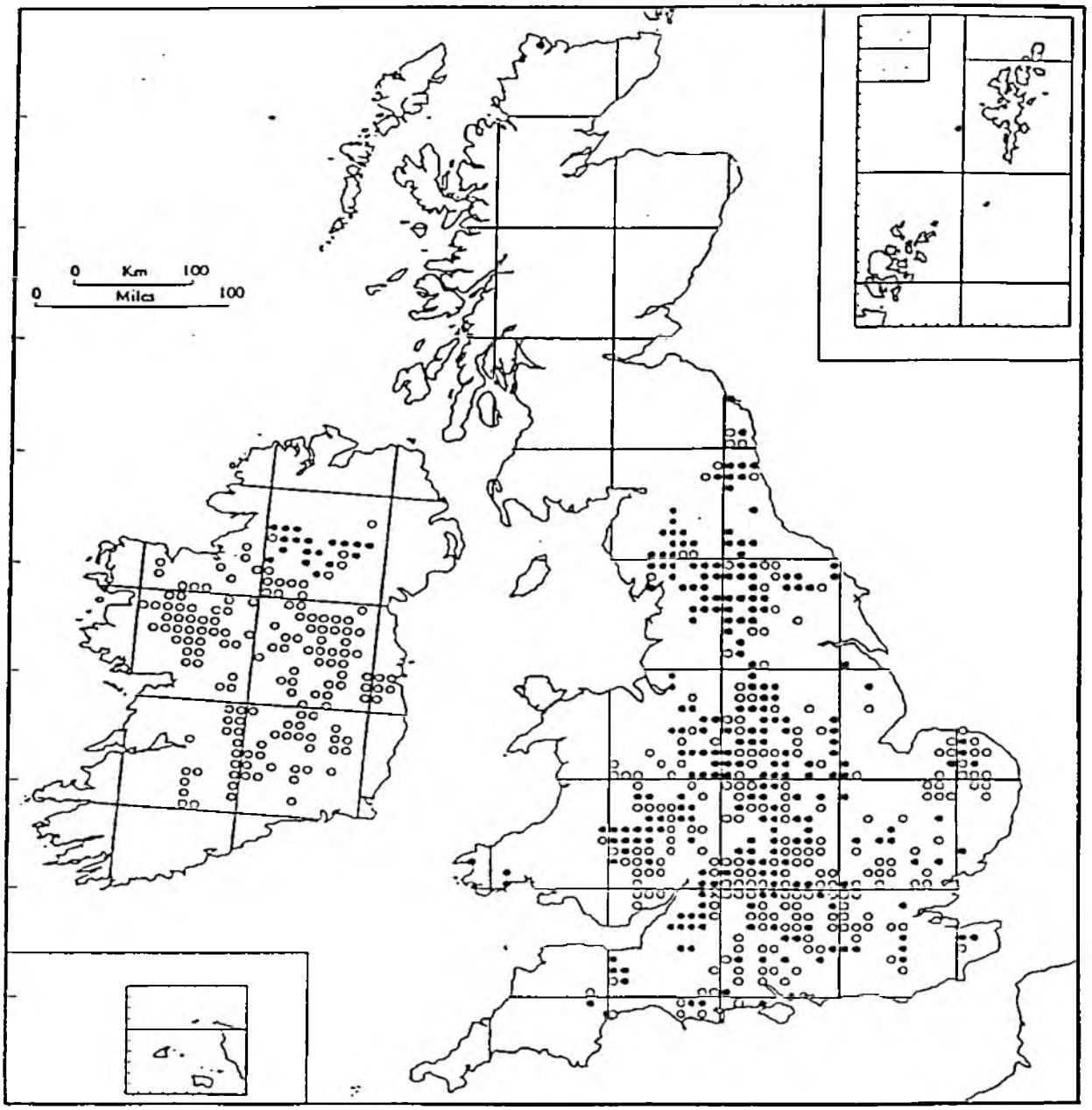

Figure 4. Distribution of *A. pallipes* in the British Isles at the 10 km square level for the periods 1990 - 94 (●) inclusive and before 1990 (o). Based on a map produced by the ITE Environmental Information Centre, Monks Wood.

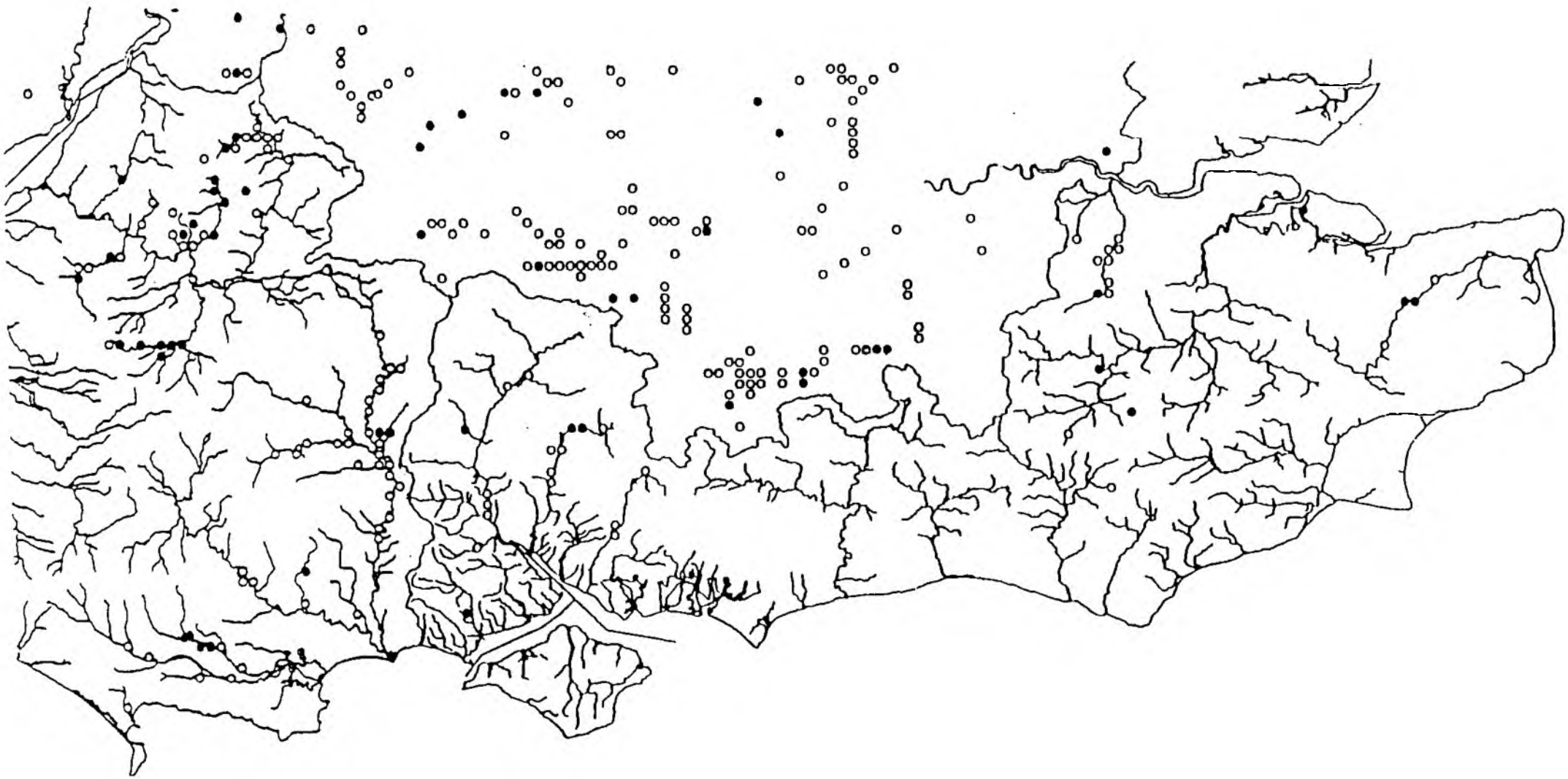

Figure 5. The distribution of *A. pallipes* before 1990(o) and after 1990 (•) at the 2 km square level in the Southern Region

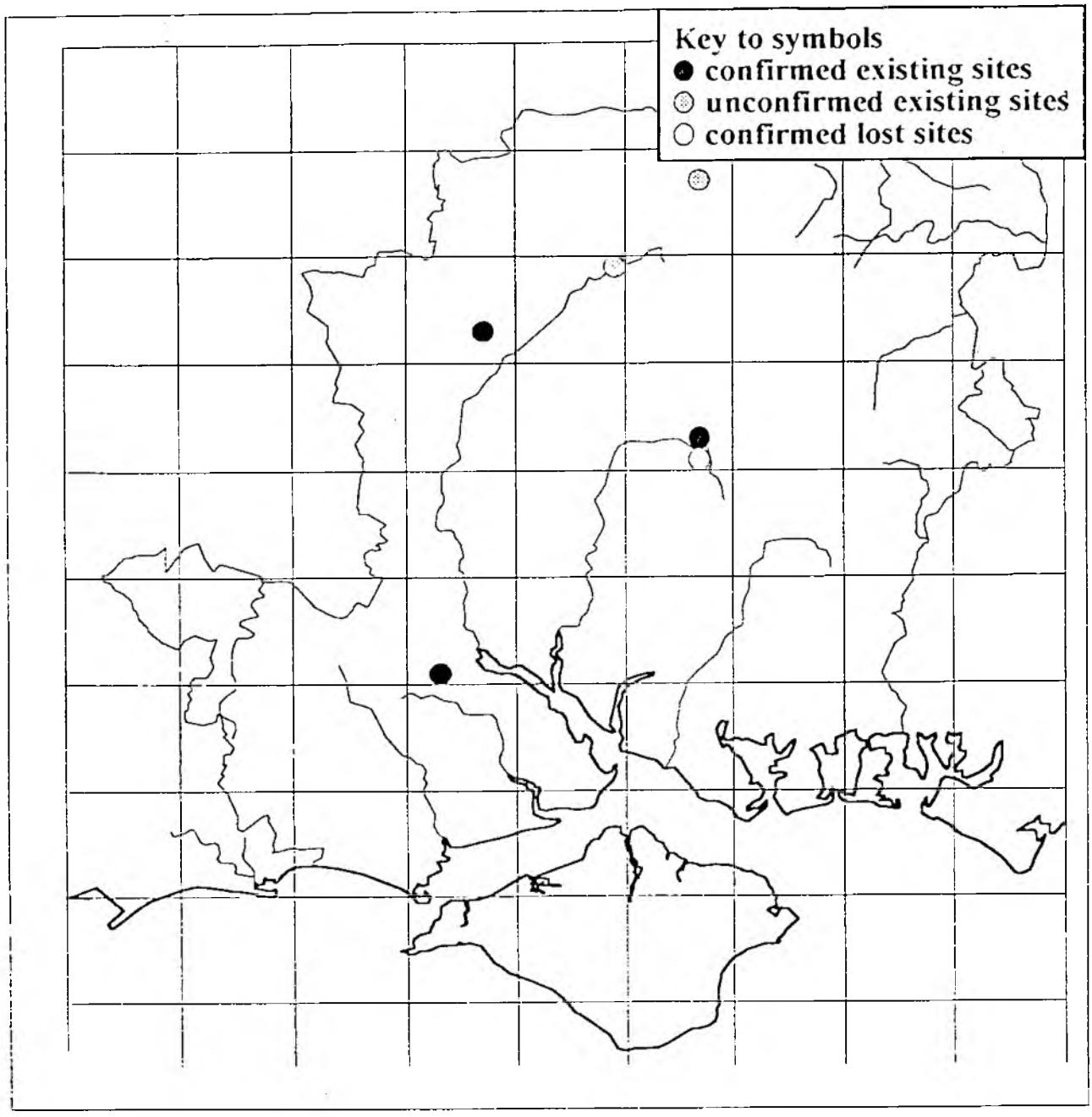

Figure 6. The current (1997) known distribution of *A. pallipes* in Hampshire

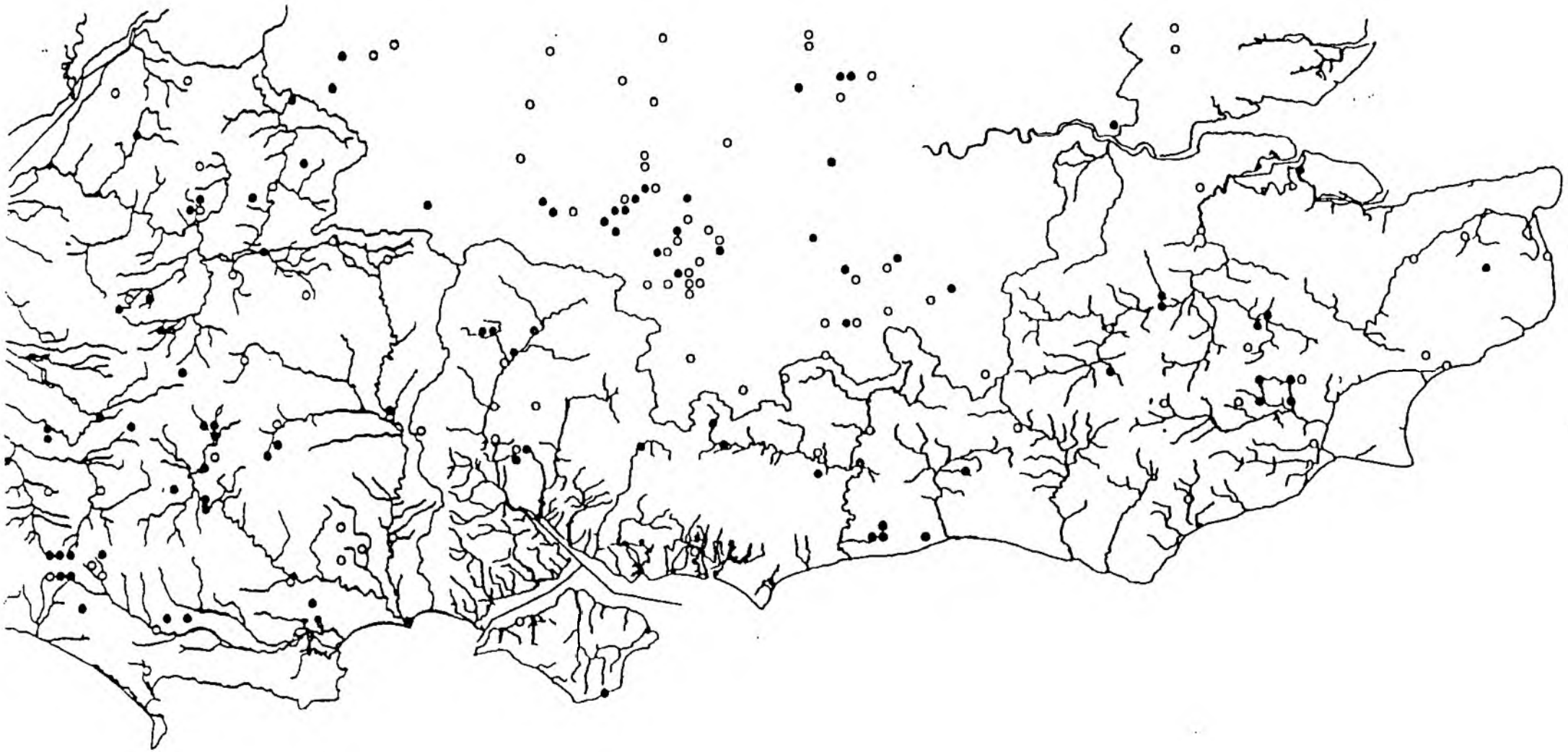

Figure 7 The distribution of signal crayfish *Pacifastacus leniusculus* before 1990 (o) and after 1990 (•) at the 2 km square level in the Southern Region

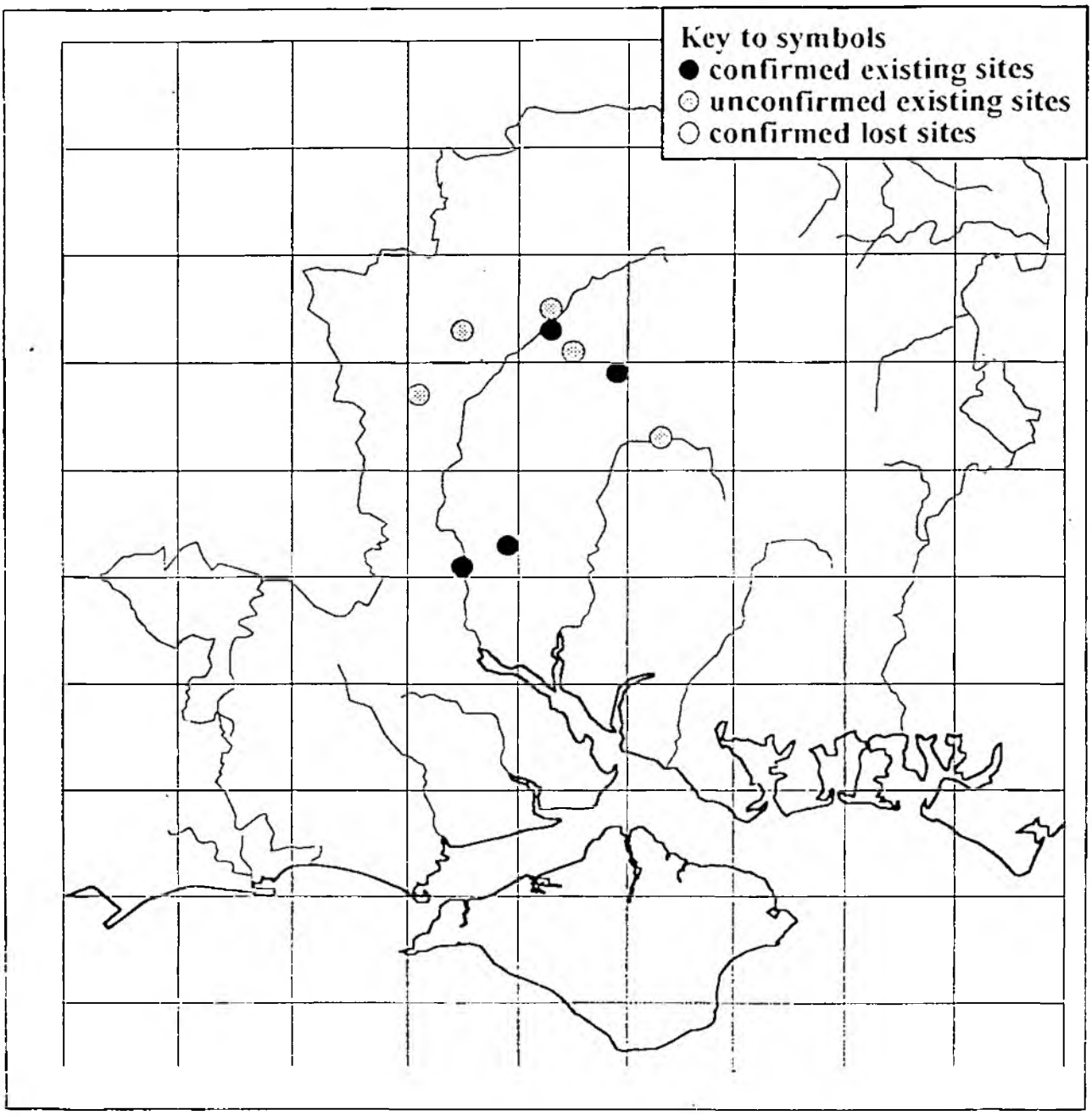

Figure 8. The current (1997) known distribution of signal crayfish *P. leniusculus* in Hampshire